Project Title: SMART MOP ROB (Smart Robot Vacuum Cleaner)

TEAM NO. : 275

NAMES OF THE STUDENTS PARTICIPATED IN THE TEAM: SUMANTH RAO CS, SHANKAR SINGH C, M BALASUBRAMANIAN, PRATIK SHRIKANT RAO

COLLEGE: JSS ACADEMY OF TECHNICAL EDUCATION, BANGALORE

SEMESTER: 7

DEPARTMENT: ECE/CSE

CITY: BANGALORE

STATE: KARNATAKA

PROJECT MENTOR NAME: MR YOGESH RAJE

Project Details:

1. Design and develop a fully autonomous robotic vacuum geared for open environments with collision avoidance system.
2. Dirt and trash detection capability using live feed, having efficiency **significantly higher** than models existing in current literature.
3. Develop a web interface for displaying details and android interface for manual motion.

Problem Statement:

Development of a smart autonomous robot vacuum cleaner to automate the floor cleaning operation.

Need of Project:

From the very beginning of the human era, cleaning was one of the tedious and time-consuming tasks. Technologies are part of human life and help them in order to complete their tasks. There were many methods are available for cleaning the premises. But those methods were tedious, scary and needed high effort. People using sweep and mop for cleaning the households. It became difficult for working people to find time for cleaning. Most of the people usually using a hand-controlled mop for mopping the floor. So, there might be chances to reduce manpower and human efforts. Using conventional floor cleaner needed a lot of effort and supervision from the user. Because of these difficulties, the existed system was not considered as an efficient method. As the improvement in the innovation of technology, with the help of automation, this task was made much more efficient and easy.

The robotic cleaners have taken major attention in robotics research due to their effectiveness in assisting humans in floor cleaning applications at homes, hotels, restaurants, offices, hospitals, warehouses, and educational institutions, etc. It is an electromechanical machine and used for various purposes in domestic applications. Although devices such as washing machines and dishwashers have served this purpose, it still requires some degree of human input effort. In developing a floor cleaning robot, there are several challenges that one has to come in front, i.e. the method of cleaning, path planning, covering the whole floor surface, cleaning it completely, maintenance so on and so forth. It becomes even more complicated when safety, economy, energy consumption are considered to be at the optimum level. Initially, the main focus was on having a household cleaning device robot.

Basically, the robotic cleaners are classified on their cleaning technique like floor mopping, dry vacuum cleaning, sweeping, etc. Some robotic cleaners are based on simple obstacle avoidance using infrared sensors while some utilize laser mapping technique for navigation. All cleaning and operating mechanism of robotic floor cleaners have their own advantages and disadvantages. For example, robots utilizing mapping technique are relatively faster, and energy efficient but these are costly, while obstacle avoidance based robotic cleaners are relatively less time consuming and less energy efficient due to random cleaning of the floor.

In early, 2010 a new automatic floor cleaner robot “Mint” was developed by Jen Steffen. Detachable clothes were attached for sweeping and mopping purposes. For tracking mint robot used the GPS-like indoor localization system. It depends on the data of one specific sensor and arrangement the development as indicated by it. The most exceptional frameworks made by IROBOT and SCOOBA have utilized data from different sorts of sensors. The smoothness and versatility can depend on distinctive sensors for building the robot self-governing.

The main purpose of this paper is to design and develop an automatic floor-cleaning robot that will make mopping operations more efficient and easier. It reduces the cost of cleaning and human efforts. It will assist people at home who are too busy for daily floor cleaning, especially for job working people who do not have enough time to clean.

In this project , the robot has the capability of obstacle detection and avoidance using computer vision and sensors, uses machine learning to map the area that needs to be cleaned without needing blueprints of the room it is in, and uses edge detection to avoid altitudes. Using GPS technology it can implement self-charging technology, where is goes back to the point where it was previously charged on its own. In its manual mode, using an app it can be fully controlled by a human from the mobile, and its battery can be monitored.

Utilising modern day concepts of ML, IOT, Computer Vision and Power Electronics, it stands as a product and concept that is indigenous, as there are no companies in India that are producing a product with the same concepts.

We categories our product to be different from the other existing projects due to three main factors: edge detection , mapping algorithm for floor , cost reduction.

After a survey, we would like to propose a starting budget of 15000 rupees as a starting fund to get this process on the rail so it is up and going. For a measure, the expense range of the products in the market go from a minimum of 20000 to 70000 rupees, which can be seen on amazon. We want to build a robot of a higher calibre and given new concepts for not more than its minimum range today. We would be thankful to receive the same. This report further elaborates technical details.

Proposed Solution:

The main objective of this project is to include the latest features of the robot available in market at lower costs . features such as obstacle avoidance , edge detection , mapping of the floor is the main focus along with the removal of dirt.

Thus, developing a robot droid capable of efficiently cleaning the floor of homes, offices, industries solves the tedious job of cleaning – sweeping and mopping the floor manually.

The proposed system developed reduces the human intervention in floor cleaning tasks.

Technology Used:

The robot is consisting of different domains which includes Internet of things , ML/Image processing used for object detection. The working of this robot can be explained with these aspects .

The movement algorithm is designed using Python which runs on Raspberry Pi 3 Model B. The robot operates in two modes – autonomous and manual. Manual motion is achieved by using the inbuilt Bluetooth of Raspberry Pi and a mobile application used to control the motion of the robot.

The sensor data – data from IR and ultrasonic sensors is also used to provide inputs in order for the movement algorithm to work effectively by avoiding obstacles to prevent collision and detect edges to prevent the robot from falling down the stairs, etc.

A ML model is created using YOLOv7 for dirt classification which is capable of classifying whether the object is a dirt or not. This results in used in the collection of dirt by a method which is discussed in future works.

The robot comes with a web application, thus IoT is implemented to communicate with the robot and user. The website is created using Streamlit and Firebase where the robot sends live data to the website for analysis and monitoring.

Project Outcomes:

The main expected outcome from this project Is to demonstrate the use of latest features available in the robots in the market along with the reduction of cost .
The sensor data collected must be utilised efficiently for the various features to work.

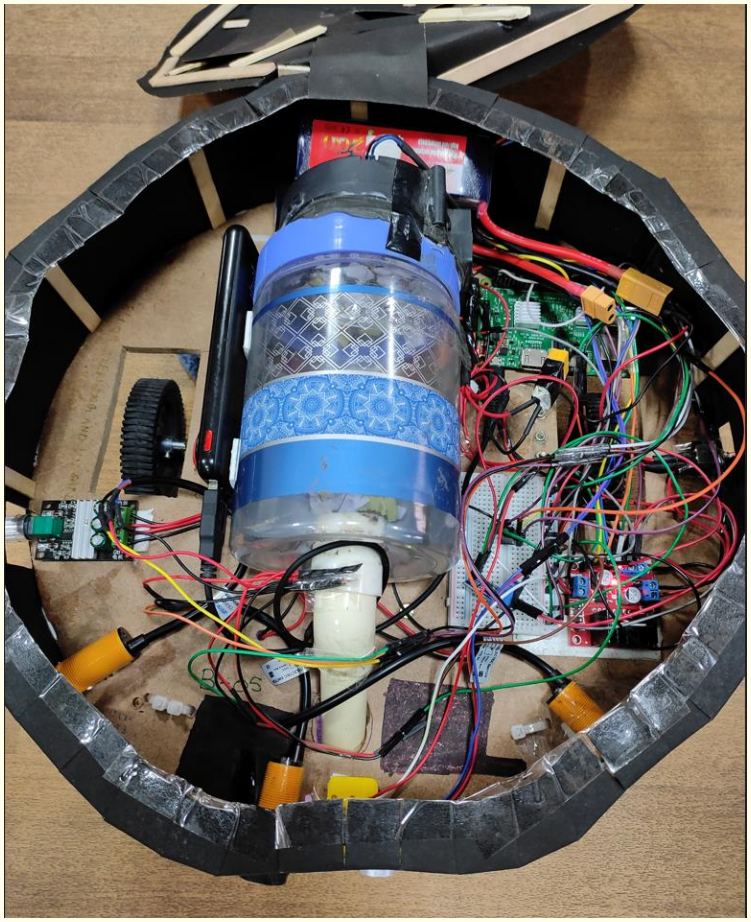
- Indigenous

- Higher mAP and lower false alarm rate in DL model, far surpassing the results of current literature
- Geared towards open environments
- Dirt Detection with camera
- Reduced Cost (Quality products in the market go upto Rs. 75k)

Modelling:

A prototype of the robot is designed using various hardware components.

The robot consists of a base where the wheels sensors and other supporting components are mounted . Holes are cut to make the suction hole for the vacuum pump to suck the dirt particles. The placement of components is made in such a way that there will not be any overlapping which may lead to heating due to the use of microcontroller boards and various motors. The sensors are situated at the sides for obstacle detection and at the bottom for edge detection. The camera will be placed at the front to object and dirt detection.

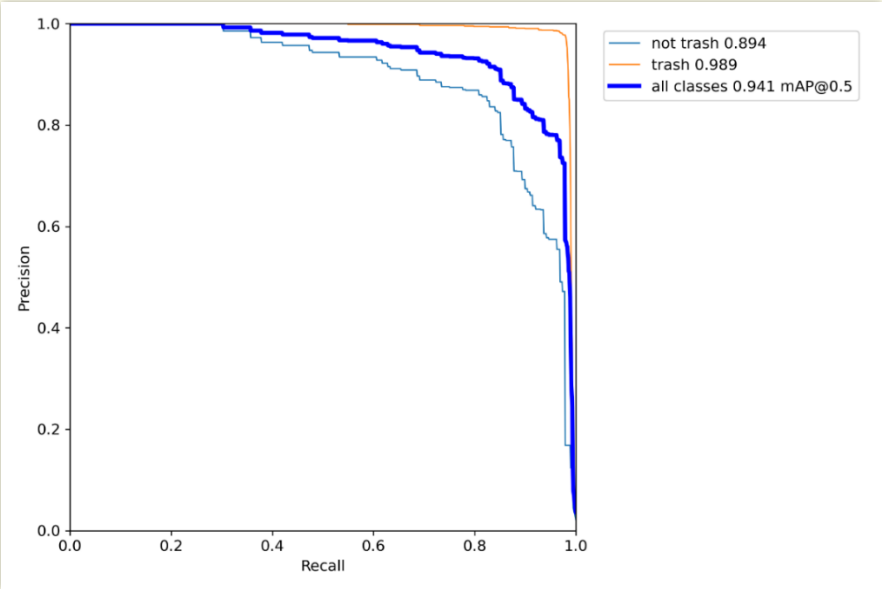


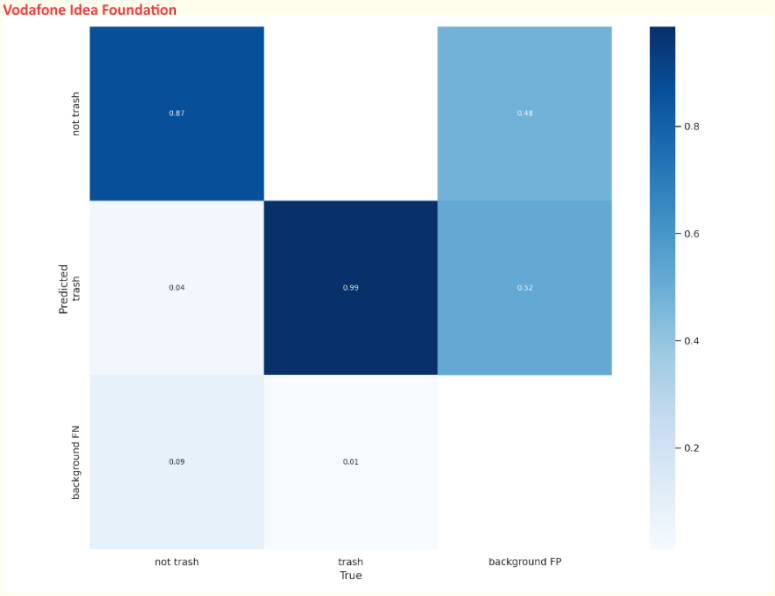
Results:

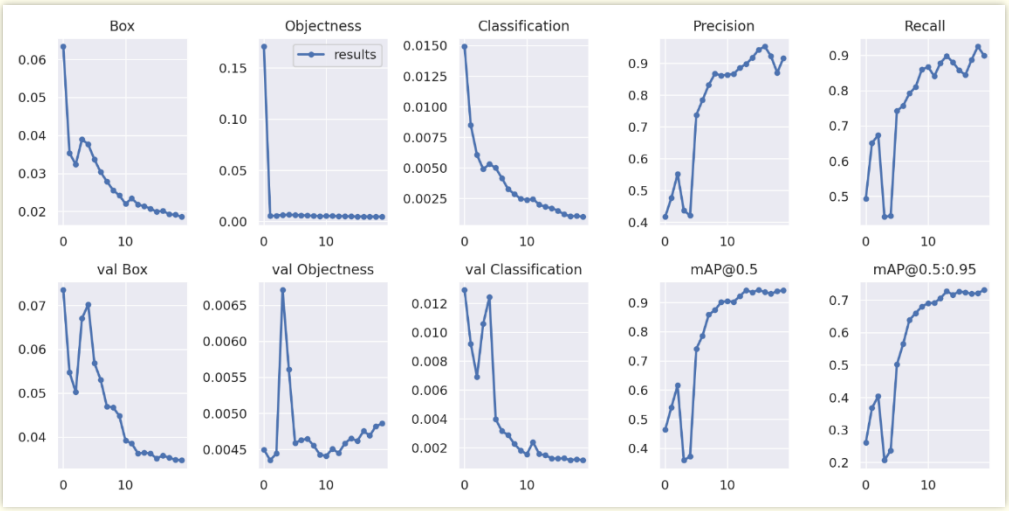
The robot can achieve an efficient cleaning functionality of the floor by following the designed snake movement algorithm.

The robot system collects various data from its surrounding for leaning and processing. The external data includes the distance of obstacles or the floor or any object or dirt. These external data are captured with the help of sensors, in this case, IR sensors, ultrasonic sensors and camera.
IR sensor captures and detects the presence of floor underneath. ultrasonic sensors collect the distance of objects from the robot in order to avoid the collision of robot with the object.

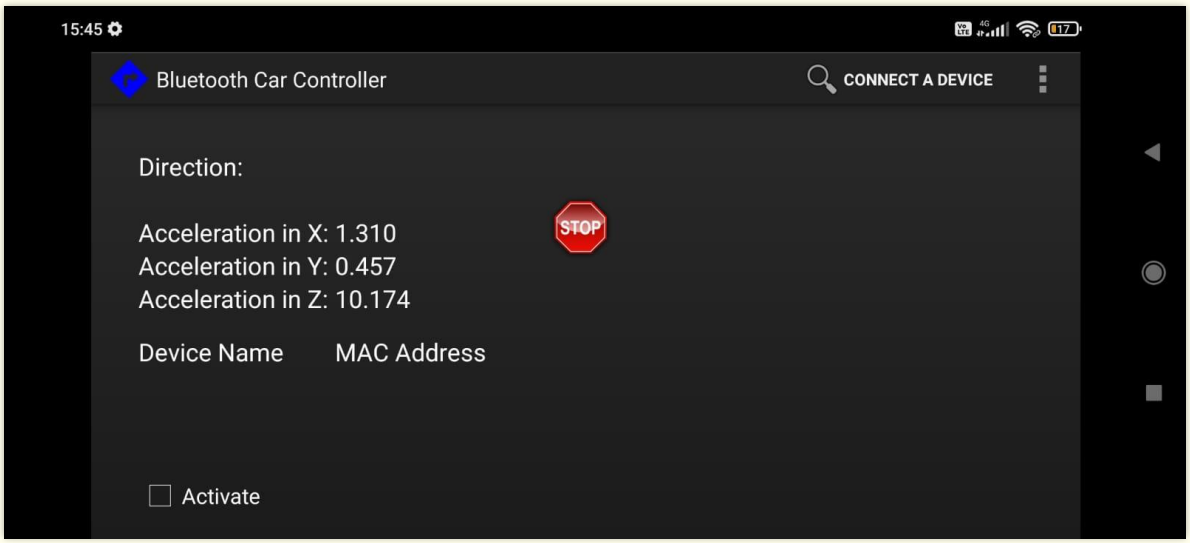
The ML model which is designed using YOLOv7 achieved an accuracy with **mAP=94.1%** and at **IoU=0.5. False Alarm rate: 1.1% , True Positive Rate: 98.9%** when compared to the DirtNet which has **Best mAP= 83.7%** and **False Alarm rate: 45% .**



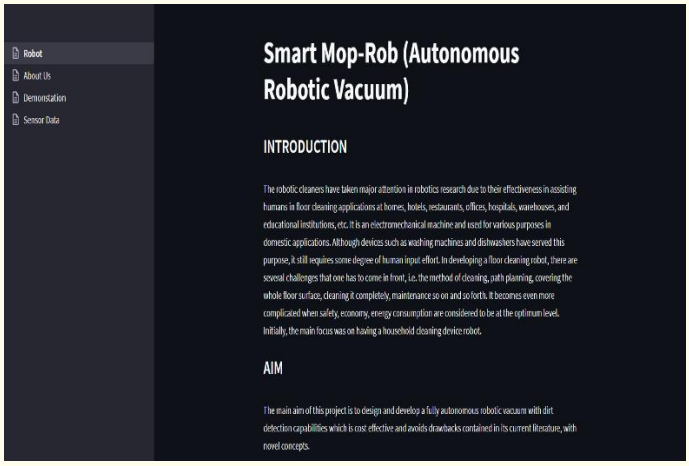




Manual Motion Application Interface:



Website Interface:



Future scope for project enhancement:

- High resolution camera and robotic arm
- Automatic charging dock
- Generating larger dataset using logic proposed in Dirtnet
- Advanced sTetro staircase motion for open environments